Workshop on Wireless Sensing

Summary of Workshop Discussions

Sensors Conference 2001, Chicago, IL **Monday, June 4, 2001**

HOME

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

Why use wireless at all?

Some attendees at the conference questioned whether wireless communications for sensors should even be considered at all. For applications such as high-speed process control, wireless might not be the best solution. In those cases, wired, dedicated sensors may be the best solution. However, in many cases where processes exist over a large facility or are low enough speed, wireless may be a best-fit solution since the cost of cabling can be exorbitant when compared to the cost of the sensor itself.

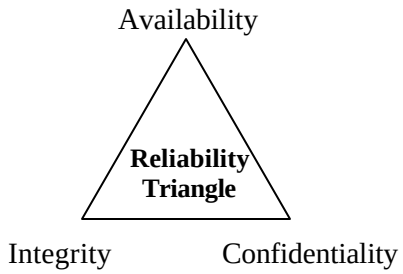
Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

What is data reliability and how does it affect wireless sensors?

Data reliability was the largest issue raised during the workshop. Data reliability depends on three factors: availability of the wireless signal, integrity of the data message, and confidentiality of the data message. These three factors were brought up in many different forms all throughout the presentations and discussions at the workshop.



Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

What is data reliability and how does it affect wireless sensors?

Availability of the wireless signal is the physical side of the reliability triangle. Some issues related to the availability are range, interference, and data throughput. "*Range is everything!*" By increasing the range of a signal, the signal is less prone to multi-path effects and small signal interference. "*The good news about the ISM band is you don't need a license. The bad news is nobody else does either.*" Many of the wireless sensors available or being developed use the Industrial, Scientific and Medical (ISM) bands for their transmission. This allows them the freedom of not relying on the Federal Communications Commission (FCC) for regulation of signal. However, it also limits power and sole proprietorship for a particular bandwidth. Many of the data transmission algorithms used today have compensation built-in to overcome interference in some way.

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

What is data reliability and how does it affect wireless sensors?

Some of the standards developed for wireless communications allow multiple data throughput speeds to be used depending on the distance between the transmitter and receiver. IEEE 802.11b allows the throughput to step down from 11 to 5.5 to 1 Mbps if the two systems begin to move outside the recommended operating range.

Data integrity and confidentiality are the software components of the reliability triangle. In order for modern wireless communications to send reliable data from one place to another, the integrity of that data needs to be checked. Data integrity basically establishes that the bits you send get to the receiver and that they receive the correct bits of data. Many of the wireless communication algorithms developed today have some sort of data

What is data reliability and how does it affect wireless sensors?

integrity or error correction checks built-in, such as cyclical redundancy checks (CRC). More complicated algorithms use some sort of forward error correction that allows for correcting errors without requesting the signal be sent again. These algorithms can increase the effective bandwidth of a communication link, since there are fewer requests for re-transmission made by the devices on the network. The IEEE 1451.2 specification for a Transducer Electronic Data Sheet (TEDS) has error correction built-in using a checksum, but requires the user to include their own error detection code if they want a more complicated algorithm.

Data confidentiality relates to the security of the signal being sent from one system to another. This can be an important feature of some wireless

Summary of Workshop Discussions

What is data reliability and how does it affect wireless sensors?

communication systems, since companies worry about having their data co-opted by a competitor. As more and more data is stored and moved digitally, industrial espionage has become an ever more present threat to companies.

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

What are users particular bandwidth requirements?

An informal survey of the bandwidth requirements for workshop attendees was conducted. The results are as follows.

Bandwidth	Interested Parties
<= 300 bps	63%
300 bps – 50 kbps	25%
50 kbps – 250 kbps	3%
250 kbps – 1.5 Mbps	6%
> 1.5 Mbps	3%

Summary of Workshop Discussions

Where should the wireless communications be located?

Many of the attendees at the workshop were of the opinion that the wireless communications should not be included directly on the sensors for cost reasons as seen in Figure 1A. Smart Transducer Interface Modules (STIMs) as defined in IEEE 1451.2 consist of sensors and/or actuators, signal conditioning circuit and digital data output. The attendees decided that it would be better to have sensors attached to some sort of wireless NCAP node as shown in Figure 1B, which then communicates to a wired network via a gateway. Network Capable Application Processor (NCAP) is defined in the IEEE 1451.1 as a sensor network node.

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL **Monday, June 4, 2001**

Summary of Workshop Discussions

Where should the wireless communications be located?

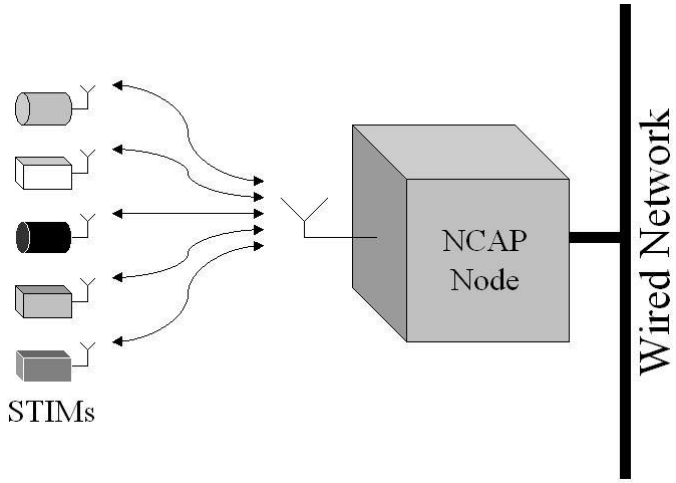


Figure 1A. Wireless STIMs

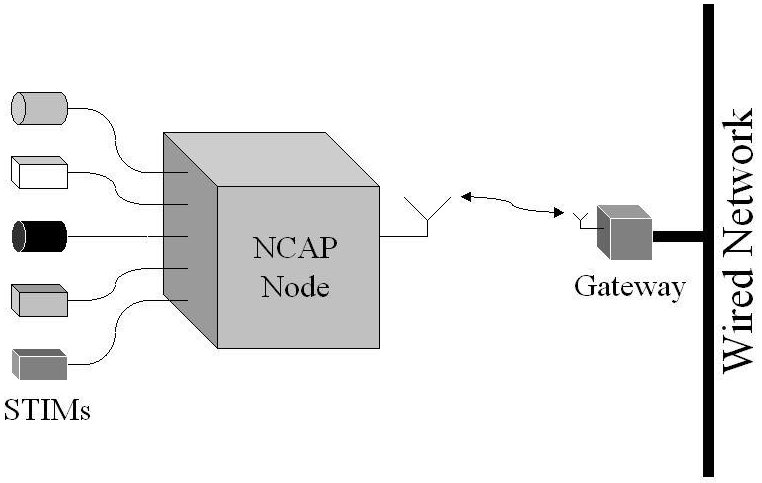


Figure 1B. Wireless NCAP Node

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

How many devices per node do users require?

NCAP nodes allow multiple sensors to be attached to the network using one common point of access. These allow for the communication portion of the sensor network to be taken out of the sensors themselves and distributed between multiple sensors via a separate piece of hardware. An informal survey was taken of the numbers of sensors for each node. The results are as follows.

Sensors/Node	Interested Parties
8	26%
32	53%
256	21%

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

How does wireless transmission power affect battery lifetime and safety?

Another issue raised at the workshop had to do with the power requirements of some of the wireless communication standards. Some of them require "high" power (100 mW), which may not be available in small battery operated sensors. The expected battery life of some of the planned sensor needs to be on the order of years, which limits the power consumption allowed for the communication system. Replacing batteries in some machines may not be as easy as it would be for a typical cell phone.

There are also issues of the intrinsic safety of such "high" power communications when used in hazardous environments. The Occupational Safety and Health Administration (OSHA) has restricted the use of wireless

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

How does wireless transmission power affect battery lifetime and safety?

Ethernet in chemical plants and refineries for the lack of safety certifications. Wireless communication is also not allowed for fail-safe systems such as emergency stop systems where lives are at stake.

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

How can wireless sensors benefit from the "hot" wireless technology?

During the workshop presentations, the topic of cost was brought up related to both the basic chip sets for and devices using different wireless communication standards. Although the Bluetooth and 802.11b standards may not be the best fit for all applications in the sensor community, the fact that devices using the chip sets based on these standards are developed in mass quantities for the mobile computing community means that the chip sets will come down in price due to economy of scale. With custom application specific integrated circuit (ASIC) chips for wireless communications, the best algorithms for a particular application could be implemented, however, the device would cost considerably more due to the development cost of the chip set itself. Although the IEEE 1451 standard is being developed for most applications, it should not eliminate such

Summary of Workshop Discussions

How can wireless sensors benefit from the "hot" wireless technology?

standards as Bluetooth and 802.11b due to their enormous backing and potential in wireless communications.

Even though the production chip sets for a particular wireless communication standard may be inexpensive, the cost for the development system may be thousands of dollars. This cost could easily be amortized if a company plans to sell thousands of units, but if it plans to be a custom design house, it may be prohibitively expensive to make up for the startup costs for these standards.

Summary of Workshop Discussions

How can sensors be reconfigured in place?

Some devices may require different communication speeds for different tasks. Configuring the device initially or upgrading the device's software may require a high-speed 2-way link that allows for a large amount of data to be transmitted all at once. Once the device starts operating normally, it may only require a small amount of bandwidth, especially if the sensor has some intelligence built-in.

Summary of Workshop Discussions

What if more than one system needs the sensor data simultaneously?

The question about whether the communication should be broadcasted or targeted came up. Broadcast communications allow one producer to broadcast its information to multiple receivers without knowing who they are or how many receivers are listening. Although this may be good in some cases, it is not appropriate in all cases. Many networks do not allow this type of communication, so the issue will need to be addressed. As of yet, it has not been brought up in the IEEE 1451 standard.

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

Can multiple wireless sensors synchronize their data at high speed?

Event synchronization may be difficult at less than 1 ms using standard wireless communications. Some standards have built-in time synchronizing capabilities due to the fact that they must do something every so often in order to stay as part of the network. Bluetooth devices, for example, must hop frequencies every 625 μs, making synchronizing at 1 ms very easy. To go much farther down would take a special timing chip set on the device that is capable of special synchronization in order to coordinate multiple devices. A proposed IEEE P1588, titled A Standard for Precise Clock Synchronization in Networked Measurement and Control Systems, is being developed in the IEEE Instrumentation and Measurement Society's Technical Committee on Sensor Technology to address this kind of issue.

Summary of Workshop Discussions

Can the NCAP and STIM be combined?

As specified in the standard, IEEE 1451.2 defined a physical 10-wire connection between the NCAP and STIM. This was done to allow the plug and play of sensors and networks from different manufacturers. However, the standard does not preclude the NCAP and STIM to be co-located inside the same chip. In such configuration, the interface between the NCAP and STIM is not exposed for consideration of plug and play, therefore the 10-wire interface is not important or necessary.

Summary of Workshop Discussions

Can the ISM bands support the extra users?

The FCC has certain bandwidths that it has declared open to unlicensed equipment as long as that equipment stays within certain power requirements. These bandwidths are called the ISM bands, and many wireless communication devices use these bands. Here is a listing of some of the ISM bands and devices that use those bands:

- 900 MHz — Cell phones, portable phones, home electronics, spread spectrum communications
- 2.4 GHz — Portable phones, spread spectrum communications
- 5 GHz — Satellite communications

HOME

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

Are multiple versions of the IEEE 1451 wireless standard needed?

It may be necessary to look into multiple flavors of a wireless IEEE 1451. There seems to be enough differences between the low and high-speed sensor communities that multiple standards within the IEEE 1451 framework may be necessary to meet the needs of the two worlds, unless there is a way to define the specification to accommodate the requirements of both groups. This can be a way to break out discussions of power consumption as well, since the high-speed community may not have the same requirements for power consumption as the low-speed community.

Although there were some negative comments, many workshop attendees seemed open to the idea of creating a wireless version of IEEE 1451. A general comment was that the IEEE 1451 committee had done a very good

Summary of Workshop Discussions

Are multiple versions of the IEEE 1451 wireless standard needed?

job developing a standard for smart sensors. Enough interest had been developed in the industry that more manufacturers and users were looking into the standard for their particular applications.

Workshop on Wireless Sensing

Sensors Conference 2001, Chicago, IL Monday, June 4, 2001

Summary of Workshop Discussions

Should there be another workshop organized?

There are multiple upcoming conferences, and it would be good to organize a follow-up workshop at one of these. The possible candidates include:

- September 10-13, 2001 — ISA 2001, Houston, TX
- October 2-4, 2001 — Sensors Expo, Philadelphia, PA
- November 5-7, 2001 — SIcon 2001, Chicago, IL

The next workshop is scheduled to be held on October 4, 2001 at the Sensors Expo/Conference in Philadelphia, PA. At the follow-up workshop, a strawman should be developed for applying the IEEE 1451 to a particular wireless sensor application in order to help develop the standard further. Also, some tools for developing the standard should be discussed. These

Summary of Workshop Discussions

Should there be another workshop organized?

tools can be either hardware tools such as very high density layout (VHDL) development packages or software tools such as unified modeling language (UML) and object-oriented design tools.

Summary of Workshop Discussions

How will the proceedings for this workshop be distributed?

Information about this workshop and its proceedings will be made available in both electronic and paper form. Electronic forms can be obtained on compact disk (CD) and from the web. The web address for information is http://ieee1451.nist.gov.